Science Standards of Learning

Sample Scope & Sequence

Physical Science

Commonwealth of Virginia
Department of Education
Richmond, Virginia
2003

Virginia Department of Education
P.O. Box 2120
Richmond, Virginia 23218-2120
http://www.doe.virginia.gov

Superintendent of Public Instruction
Jo Lynne DeMary

Deputy Superintendent for Instruction
Patricia I. Wright

Assistant Superintendent for Instruction
Linda M. Wallinger

Office of Elementary Instructional Services
Linda Poorbaugh, Director
Paula J. Klonowski, Science Specialist

Office of Middle and High School Instructional Services
James C. Firebaugh, Director
Eric M. Rhoades, Science Specialist

NOTICE TO THE READER
The Virginia Department of Education does not unlawfully discriminate on the basis of sex, age, race, color, religion, handicapping conditions, or national origin in employment or in its educational programs and activities.

Preface

As an additional resource to help school divisions develop curricula aligned to the 2003 Standards of Learning, the Virginia Department of Education has developed sample scope and sequence documents for kindergarten through grade eight and for core high school courses. These sample documents provide guidance on how the essential knowledge, skills, and processes that are identified in the Standards of Learning and the Standards of Learning Curriculum Frameworks may be introduced to students in a logical, sequential, and meaningful manner.

These sample scope and sequence documents are intended to serve as general guides to help teachers and curriculum developers align their curricula and instruction to support the Standards of Learning. Each sample document is organized around specific topics to help teachers present information in an organized, articulated manner. Also included are correlations to the Standards of Learning for that curricular area for a particular grade level or course, as well as ideas for classroom assessments and teaching resources.

The sample scope and sequence documents are not intended to prescribe how curriculum should be developed or how instruction should be delivered. Instead, they provide examples showing how teachers and school divisions might present to students in a logical and effective manner information that has been aligned with the Standards of Learning. School divisions that need assistance in developing curricula aligned with the Standards of Learning are encouraged to consider the sample scope and sequence guides. Teachers who use the documents should correlate the content identified in the guides with available instructional resources and develop lesson plans to support instruction.

The *Science Standards of Learning Sample Scope and Sequence* and the *Science Standards of Learning Curriculum Framework* can be found in both PDF and Microsoft Word file formats on the Virginia Department of Education's Web site at http://www.doe.virginia.gov/VDOE/Instruction/sol.html.

Introduction

The following sample scope and sequence is based on the essential content, skills, and processes developed for each Physical Science standard in the *Science Standards of Learning Curriculum Framework*. It is not intended to be a complete or exhaustive set of all that students should master at this level, but instead the scope and sequence organizes a core of key skills, content, and processes around basic topic areas.

The topic areas generally correspond to individual standards; however, certain standards are reorganized and grouped with components of other standards to comprise meaningful instructional clusters. The various topics are not intended to require equal instructional time. Additional objectives have not been developed, and no attempt has been made to transition or further explain the content. In some cases information from the Curriculum Framework overview has been reconstructed and included with the essential content skills and processes. Additional information may be obtained from the overview and introductory sections of the *Physical Science Standards of Learning Curriculum Framework* (http://www.doe.virginia.gov/VDOE/Instruction/Science/sciCF.html).

An important and consistent thread among these organizational topics is the application of inquiry skills throughout. Students should have an opportunity to master the various science concepts in each topic area in the context of active learning and inquiry processes. The focus on inquiry is further reinforced by having the first topic in the scope and sequence as a discrete treatment of the science skills; however, a discrete treatment is certainly not required. This represents only one way to organize instruction; there are many other valid and useful organizational schemes.

Effective science teaching requires assessing and understanding what students know and need to learn and then challenging and supporting them to learn it well. The array of effective assessment techniques that teachers can employ in the classroom goes well beyond traditional assessments, and science instruction lends itself well to alternative approaches such as portfolios, student self assessments, and short videotaped presentations. The assessments mentioned in the scope and sequence are intended to be general. It is the role of the local curriculum to develop a detailed review of what is most effective for the particular concept being developed.

The resources section included in this scope and sequence provides a brief sample of instructional resources and staff development materials that are generally available without charge. There is a significant body of commercially available instructional materials that correlates well with the Science Standards of Learning and is of very high quality. This document, however, does not include references to those materials.

Organizing Topic	Related Standards
Investigation Skills and the Nature of Science	**PS.1**
Investigating the Characteristics of Matter	**PS.2c-f, PS.5a, PS.1**
Investigating Atoms and Atomic Theory	**PS.2a, PS.3, PS.1**
Investigating the Periodic Table	**PS.4 a, PS.1**
Investigating Chemical Bonds and Changes	**PS.2b, PS.4 b-c, PS.5c, PS.1**
Investigating Nuclear Reactions and Radioactivity	**PS.5b, PS.1**
Investigating States and Forms of Energy	**PS.6, PS.1**
Investigating Heat and Heat Transfer	**PS.7, PS.1**
Investigating Sound	**PS.8, PS.1**
Investigating Light and the Electromagnetic Spectrum	**PS.9, PS.1**
Investigating Electricity and Magnetism	**PS.11, PS.1**
Investigating Force and Motion	**PS.10 a-b, PS.1**
Investigating Work and Power	**PS.10 c-d, PS.1**

Organizing Topic	Essential Knowledge, Skills, and Processes	Related SOL	Sample Classroom Assessment Methods	Sample Resources
Investigation Skills and the Nature of Science (A discrete introduction to specific science skills is not necessary, as all of the inquiry skills should be incorporated within the following topical areas. Teachers may consider introducing some of these skills in isolation or coordinated with mathematics, English, and history instruction.)	**Students should be able to:** select appropriate equipment (triple beam balances, thermometers, metric rulers, graduated cylinders, electronic balances, or spring scales) and utilize correct techniques to measure length, mass, density, weight, volume, temperature, and force. design a data table that includes space to organize all components of an investigation in a meaningful way, including levels of the independent variable, measured responses of the dependent variable, number of trials, and mathematical means. record measurements, using the following metric (SI) units: liter, milliliter (cubic centimeters), meter, centimeter, millimeter, grams, degrees Celsius, and newtons. recognize metric prefix units and make common metric conversions between the same base metric unit (for example, milligram to gram or kilometer to meter). gather, evaluate, and summarize information, using multiple and variable resources, and detect bias from a given source.	PS.1	Student demonstrations Classroom observations Student laboratory reports Quizzes Tests	*University of Virginia Physics Department: Physical Science Activities:* http://galileo.phys.virginia.edu/education/outreach/8thgradesol/home.htm# PC and Macintosh Image Processing software and training tapes (VDOE)

Organizing Topic	Essential Knowledge, Skills, and Processes	Related SOL	Sample Classroom Assessment Methods	Sample Resources
Investigation Skills and the Nature of Science (continued)	use a variety of graphical methods to display data; create an appropriate graph for a given set of data; and select the proper type of graph for a given set of data, identify and label the axes, and plot the data points. (Note: Frequency distributions, scattergrams, line plots, and histograms are described in the Mathematics Curriculum Framework, standard 7.17, pp. 27–29.) identify the key components of controlled experiments: hypotheses, independent and dependent variables, constants, controls, and repeated trials. formulate conclusions that are supported by the gathered data. apply the methodology of scientific inquiry: begin with a question, design an investigation, gather evidence, formulate an answer to the original question, and communicate the investigative process and results. communicate in written form the following information about investigations: the purpose/problem of the investigation, procedures, materials, data and/or observations, graphs, and an interpretation of the results. describe how creativity comes into play during various stages of scientific investigations.	PS.1		Probeware kits and graphing calculators SOL assessment blueprints and sample items *Science SOL Curriculum Framework:* http://www.doe.virginia.gov/VDOE/Instruction/Science/sciCF.html

Organizing Topic	Essential Knowledge, Skills, and Processes	Related SOL	Sample Classroom Assessment Methods	Sample Resources
Investigating the Characteristics of Matter	**Students should be able to:**		Student demonstrations Classroom observations Student laboratory reports Quizzes Tests	*University of Virginia Physics Department: Physical Science Activities:* http://galileo.phys.virginia.edu/education/outreach/8thgradesol/home.htm# PC and Macintosh Image Processing software and training tapes Probeware kits and graphing calculators SOL assessment blueprints and sample items
	find the mass and volume of substances and calculate and compare their densities. describe the properties of the states of matter (solid, liquid, and gas). distinguish between physical properties (i.e., shape, density, solubility, odor, melting point, boiling point, and color) and chemical properties (i.e., acidity, basicity, combustibility, and reactivity). determine the identity of an unknown substance by comparing its properties to those of known substances.	PS.2 c-f		
	design an investigation that illustrates physical changes.	PS.5a		
	design an investigation from a testable question related to physical and chemical properties of matter. The investigation may be a complete experimental design or may focus on systematic observation, description, measurement, and/or data collection and analysis. (Students should be able to use the inquiry skills represented in PS.1 and LS.1 to compose a clear hypothesis, create an organized data table, identify variables and constants, record data correctly, construct appropriate graphs, analyze data, and draw reasonable conclusions.)	PS.2		

Organizing Topic	Essential Knowledge, Skills, and Processes	Related SOL	Sample Classroom Assessment Methods	Sample Resources
Investigating the Characteristics of Matter (continued)	apply the PS.1 science skills in the context of the content of this topic.	PS.1		

Organizing Topic	Essential Knowledge, Skills, and Processes	Related SOL	Sample Classroom Assessment Methods	Sample Resources
Investigating Atoms and Atomic Theory	**Students should be able to:**		Student demonstrations Classroom observations Student laboratory reports Quizzes Tests	*University of Virginia Physics Department: Physical Science Activities:* http://galileo.phys.virginia.edu/education/outreach/8thgradesol/home.htm# PC and Macintosh Image Processing software and training tapes Probeware kits and graphing calculators SOL assessment blueprints and sample items
	describe the particle theory of matter.	PS.2a		
	describe the historical development of the concept of the atom and the contributions of Dalton, Thomson, Rutherford, and Bohr. use the Bohr model to differentiate among the three basic particles in the atom (proton, neutron, and electron) and their charges, relative masses, and locations. compare the Bohr atomic model to the electron cloud model with respect to their ability to represent accurately the three-dimensional structure of the atom.	PS.3		
	apply the PS.1 science skills in the context of the content of this topic.	PS.1		

Organizing Topic	Essential Knowledge, Skills, and Processes	Related SOL	Sample Classroom Assessment Methods	Sample Resources
Investigating The Periodic Table	**Students should be able to:**		Student demonstrations Classroom observations Student laboratory reports Quizzes Tests	*University of Virginia Physics Department: Physical Science Activities:* http://galileo.phys.virginia.edu/education/outreach/8thgradesol/home.htm# PC and Macintosh Image Processing software and training tapes Probeware kits and graphing calculators SOL assessment blueprints and sample items
	use the periodic table to obtain the following information about the atom of an element: • symbol • atomic number • atomic mass • state of matter at room temperature • number of outer energy level (valence) electrons recognize that an atom's identity is related to the number of protons in its nucleus. describe the organization of the periodic table in terms of • atomic number; • metals, metalloids, and nonmetals; • groups/families vs. periods. categorize a given element as metal, non-metal, or metalloid.	PS.4a		
	apply the PS.1 science skills in the context of the content of this topic.	PS.1		

Organizing Topic	Essential Knowledge, Skills, and Processes	Related SOL	Sample Classroom Assessment Methods	Sample Resources
Investigating Chemical Bonds and Changes	**Students should be able to:**		Student demonstrations Classroom observations Student laboratory reports Quizzes Tests	*University of Virginia Physics Department: Physical Science Activities:* http://galileo.phys.virginia.edu/education/outreach/8thgradesol/home.htm# Probeware kits and graphing calculators SOL assessment blueprints and sample items
	describe how to determine whether a substance is an element, compound, or mixture. define compounds as inorganic or organic. (All organic compounds contain carbon.) analyze the pH of a solution and classify it as acidic, basic, or neutral. describe what a salt is and explain how salts form.	PS.2b		
	compare and contrast physical, chemical, and nuclear changes. design an investigation that illustrates physical and chemical changes. given chemical formulas, write and balance simple chemical equations. analyze experimental data to determine whether it supports the Law of Conservation of Mass. recognize that some types of chemical reactions require continuous input of energy (endothermic) and others release energy (exothermic).	PS.5a, c		

Organizing Topic	Essential Knowledge, Skills, and Processes	Related SOL	Sample Classroom Assessment Methods	Sample Resources
Investigating Chemical Bonds and Changes (continued)	given a chemical formula of a compound, identify the elements and the number of atoms of each that comprise the compound. recognize that the number of electrons in the outermost energy level determines an element's chemical properties or chemical reactivity. predict what kind of bond (ionic or covalent) will likely form when metals and nonmetals combined chemically. describe the difference between ionic and covalent bonding.	PS.4		
	apply the PS.1 science skills in the context of the content of this topic.	PS.1		

Organizing Topic	Essential Knowledge, Skills, and Processes	Related SOL	Sample Classroom Assessment Methods	Sample Resources
Investigating Nuclear Reactions and Radioactivity	**Students should be able to:**		Student demonstrations Classroom observations Student laboratory reports Quizzes Tests	*University of Virginia Physics Department: Physical Science Activities:* http://galileo.phys.virginia.edu/education/outreach/8thgradesol/home.htm# SOL assessment blueprints and sample items
	describe, in simple terms, the processes that release nuclear energy (i.e., nuclear fission and nuclear fusion). Create a simple diagram to summarize and compare and contrast these two types of nuclear energy. compare and contrast physical, chemical, and nuclear changes. evaluate the positive and negative effects of using nuclear energy.	PS.5b		
	apply the PS.1 science skills in the context of the content of this topic.	PS.1		

Organizing Topic	Essential Knowledge, Skills, and Processes	Related SOL	Sample Classroom Assessment Methods	Sample Resources
Investigating States and Forms of Energy	**Students should be able to:**		Student demonstrations Classroom observations Student laboratory reports Quizzes Tests	*University of Virginia Physics Department: Physical Science Activities:* http://galileo.phys.virginia.edu/education/outreach/8thgradesol/home.htm# PC and Macintosh Image Processing software and training tapes Probeware kits and graphing calculators SOL assessment blueprints and sample items
	differentiate between potential and kinetic energy. use diagrams or concrete examples to compare relative amounts of potential and kinetic energy. identify and give examples of common forms of energy. design an investigation or create a diagram to illustrate energy transformations.	PS.6		
	apply the PS.1 science skills in the context of the content of this topic.	PS.1		

Organizing Topic	Essential Knowledge, Skills, and Processes	Related SOL	Sample Classroom Assessment Methods	Sample Resources
Investigating Heat and Heat Transfer	**Students should be able to:**		Student demonstrations Classroom observations Student laboratory reports Quizzes Tests	*University of Virginia Physics Department: Physical Science Activities:* http://galileo.phys.virginia.edu/education/outreach/8thgradesol/home.htm# PC and Macintosh Image Processing software and training tapes Probeware kits and graphing calculators SOL assessment blueprints and sample items
	illustrate and explain the effect of the addition or subtraction of heat energy on the motion of molecules. distinguish between heat and temperature. compare and contrast Celsius and Kelvin temperature scales and describe absolute zero. analyze a time/temperature graph of a phase change experiment to determine the temperature at which the phase change occurs (freezing point, melting point, or boiling point). compare and contrast conduction, convection, and radiation and provide and explain common examples. explain, in simple terms, how the principle of heat transfer applies to heat engines, thermostats, and refrigerators and heat pumps. design an investigation from a testable question related to heat transfer. The investigation may be a complete experimental design or may focus on systematic observation, description, measurement, and/or data collection and analysis.	PS.7		
	apply the PS.1 science skills in the context of the content of this topic.	PS.1		

Organizing Topic	Essential Knowledge, Skills, and Processes	Related SOL	Sample Classroom Assessment Methods	Sample Resources
Investigating Sound	**Students should be able to:**		Student demonstrations Classroom observations Student laboratory reports Quizzes Tests	*University of Virginia Physics Department: Physical Science Activities:* http://galileo.phys.virginia.edu/education/outreach/8thgradesol/home.htm# PC and Macintosh Image Processing software and training tapes Probeware kits and graphing calculators SOL assessment blueprints and sample items
	model a compression (longitudinal) wave and diagram, label, and describe the basic components: wavelength, compression, rarefaction, and frequency. determine the relationship between frequency and wavelength. analyze factors that determine the speed of sound through various materials and interpret graphs and charts that display this information. describe technological applications of sound waves and generally how each application functions. design an investigation from a testable question related to sound. The investigation may be a complete experimental design or may focus on systematic observation, description, measurement, and/or data collection and analysis. (Students should be able to use the inquiry skills represented in PS.1 and LS.1 to compose a clear hypothesis, create an organized data table, identify variables and constants, record data correctly, construct appropriate graphs, analyze data, and draw reasonable conclusions.)	PS.8		
	apply the PS.1 science skills in the context of the content of this topic.	PS.1		

Organizing Topic	Essential Knowledge, Skills, and Processes	Related SOL	Sample Classroom Assessment Methods	Sample Resources
Investigating Light and the Electro-magnetic Spectrum	**Students should be able to:**		Student demonstrations Classroom observations Student laboratory reports Quizzes Tests	*University of Virginia Physics Department: Physical Science Activities:* http://galileo.phys.virginia.edu/education/outreach/8thgradesol/home.htm# SOL assessment blueprints and sample items
	design an investigation to illustrate the behavior of visible light – reflection and refraction. Describe how reflection and refraction occur. describe the wave theories of light. model a transverse wave and draw and label the basic components. Explain wavelength, amplitude, and frequency. compare the various types of electromagnetic waves in terms of wavelength, frequency, and energy. describe an everyday application of each of the major forms of electromagnetic energy.	PS.9		
	apply the PS.1 science skills in the context of the content of this topic.	PS.1		

Organizing Topic	Essential Knowledge, Skills, and Processes	Related SOL	Sample Classroom Assessment Methods	Sample Resources
Investigating Electricity and Magnetism	**Students should be able to:**		Student demonstrations Classroom observations Student laboratory reports Quizzes Tests	*University of Virginia Physics Department: Physical Science Activities:* http://galileo.phys.virginia.edu/education/outreach/8thgradesol/home.htm# PC and Macintosh Image Processing software and training tapes Probeware kits and graphing calculators SOL assessment blueprints and sample items
	explain the relationship between a magnetic field and an electric current. design an investigation to illustrate the effects of static electricity. construct and compare series and parallel circuits. create an electromagnet and explain how it works. construct simple circuits to determine the relationship between voltage, resistance, and current. compare and contrast generators and motors and how they function. identify situations in everyday life where motors and generators are in use.	PS.11		
	apply the PS.1 science skills in the context of the content of this topic.	PS.1		

Organizing Topic	Essential Knowledge, Skills, and Processes	Related SOL	Sample Classroom Assessment Methods	Sample Resources
Investigating Force and Motion	**Students should be able to:**		Student demonstrations Classroom observations Student laboratory reports Quizzes Tests	*University of Virginia Physics Department: Physical Science Activities:* http://galileo.phys.virginia.edu/education/outreach/8thgradesol/home.htm# PC and Macintosh Image Processing software and training tapes Probeware kits and graphing calculators SOL assessment blueprints and sample items
	make measurements to calculate the speed of a moving object. apply the concepts of speed, velocity, and acceleration when describing motion. explain how force, mass, and acceleration are related. differentiate between mass and weight. identify situations that illustrate each Law of Motion. solve basic problems given the following formulas: • Speed = distance/time (s = d/t) • Force = mass × acceleration (F = ma)	PS.10a, b		
	apply the PS.1 science skills in the context of the content of this topic.	PS.1		

Organizing Topic	Essential Knowledge, Skills, and Processes	Related SOL	Sample Classroom Assessment Methods	Sample Resources
Investigating Work and Power	**Students should be able to:**		Student demonstrations Classroom observations Student laboratory reports Quizzes Tests	*University of Virginia Physics Department: Physical Science Activities:* http://galileo.phys.virginia.edu/education/outreach/8thgradesol/home.htm# PC and Macintosh Image Processing software and training tapes Probeware kits and graphing calculators SOL assessment blueprints and sample items
	apply the concept of mechanical advantage to test and explain how a machine makes work easier. make measurements to calculate the work done on an object. make measurements to calculate the power of an object. explain how the concepts of work, force, and motion apply to car safety technology, machines, and rockets. solve basic problems given the following formulas: • Work = force x distance (W = Fd) • Power = work /time (P = W/t)	PS.10c, d		
	apply the PS.1 science skills in the context of the content of this topic.	PS.1		